May 6, 1930. J. M. OLIN 1,757,584

SHOT SHELL

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Fig. 1.

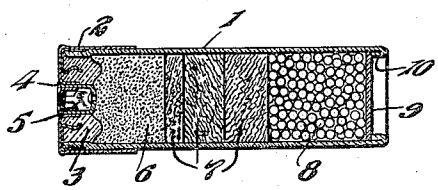

Fig. 3.

BARREL TIMES WITH LOADS LISTED BELOW.

I	.002369	SEC.
II	.002121	"
III	.002905	"
IV	.003907	"
STANDARD	.002445	SEC.

PRESSURE AT SEVERAL POSITIONS ALONG BARREL.

POSITIONS IN HAHN GUN	A	B	C	D	E	F
I 36 GR. - 1/4 OZ. #6 SH.	11036	7465	2613	1913	1468	1126
II 26.5 " " "	10586	7634	2623	1902	1400	1164
III 3 1/2 DRS. " "	10370	8158	2722	1986	1427	1190
IV 35 GR. " "	8642	8165	2840	2022	1482	1204

Fig 2.

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UNITED STATES PATENT OFFICE

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SHOT SHELL

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This invention relates to cartridges and more particularly to shot shells adapted for use in shot guns.

The barrel of a shot gun should be light, especially at the forward part, in order that the weapon may be easy to handle. Moreover even at the breech the barrel cannot be as heavy as in a rifle, when the relative bores are considered, since shot guns are of considerably greater caliber than rifles. Accordingly the powder charge in a shot gun shell is necessarily limited by the limiting breech pressure, that is, the pressure that can safely be developed at the breech, which for an ordinary twelve gauge gun is about twelve thousand pounds per square inch.

In a shot shell the propellant charge is confined by wadding, over which is placed the charge of shot, and the latter is in turn confined by its covering wad and the turned over end of the paper shell, while a primer is provided in order to ignite the powder. The wadding does not, however, form a tight seal, as does the bullet in a rifle; accordingly heretofore a quick burning powder has been used which may become consumed at the time or even before the charge leaves the shell. In other words the major part of the work was applied to the charge at the breech during the initial stage. This was necessary because of the relatively large diameter of the gun bore and the fact that on account of the lack of an efficient seal, the pressure could not be maintained along the gun barrel, as is a necessary condition to the use of a slow burning powder. Accordingly where high velocities were required, larger or over charges of powder were necessary; these charges and, therefore, the velocity were however limited by the limiting breech pressure.

As a result of the above described conditions the powder charges of shot shells have been limited to quick burning powders, for the use of slow burning powders has invariably resulted in irregular and erratic ballistics and in much unburned powder. The use of condensed or dense nitro-cellulose powders, if the grains are too large resulted in uncertainty of ignition; and even if ignited the grains would not be wholly consumed. If, on the other hand, such a dense powder was sufficiently finely divided to obtain the required rapidity of burning, then the results were too uncertain and erratic, resulting in dangerous pressures and erratic ballistics. Now one of the requirements of a shot shell, and more particularly of the propellant powder charge, is that the same shall be reliable and constant in its qualities and results, that is, shells of the same gauge should give the same results; this is not attained where they are uncertain and erratic. Furthermore as heretofore stated the velocities are limited by the limiting breech pressure, and any attempt to increase these velocities, even within quite narrow limits, will result in dangerous pressures. It should be remembered that in the manufacture of shot shells, the powder is measured and not weighed; accordingly where the powder is not uniform in its subdivision and action the results are liable to not only be uncertain and erratic, but the resulting pressure are liable to be dangerous. For the above reasons a dense nitro-cellulose powder, when sufficiently subdivided to enable it for use in a shot shell, is not satisfactory.

The burning action of dense nitro-cellulose powder is often accelerated by the addition of nitro-glycerine, or even by the addition of black powder or other ingredients. These powders, however, as well as the bulk smokeless powders, are all of the same general type and are directed towards the same end, namely to produce a propellant charge which will burn quickly and may be almost consumed at the initial stage. In none of the shot gun shells as heretofore constructed and loaded, is the maximum pressure developed or sustained for any appreciable distance along the gun barrel, but the initial pressure drops rapidly to its minimum. Accordingly the total energy utilized is practically that released upon the initial combustion of the charge.

The employment in a shot shell, of a powder in which the pressure rises so rapidly to a maximum is that the wadding and the mass of shot in front thereof are started so suddenly that the movements imparted to the various shot of the charge are unequal; ac-

cordingly the shot travel at unequal and uniform velocities towards the target; this results in "stringing of shot," which in actual practice may be so great as to greatly affect the effective accuracy on hitting a target moving across the line of flight of the shot.

One of the objects of this invention, therefore, is to provide a shot shell containing a propellant charge of a granular dense smokeless or nitro-hydrocarbon powder, and more particularly, a dense colloided nitro-cellulose powder, which is in such form and so confined as to burn progressively when fired in a shot gun, so that the combustion continues for an extended distance along the gun barrel.

Another object is to provide a loaded shot shell wherein the propellant charge consists of progressive burning smokeless powder which is adapted to sustain a nearly uniform pressure while the shot charge moves out of the shell.

Another object is to provide such a loaded shot shell in which the progressive burning smokeless powder propels the shot shell with a material reduction in the stringing of shot as compared to shells using standard smokeless powder.

Further objects will appear from the detail description taken in connection with the accompanying drawing, in which:

Figure 1 is a section of a shot shell embodying this invention;

Figure 2 is a pressure diagram illustrating the action as compared to others of the prior art; and

Figure 3 is a comparative barrel time diagram.

Referring to the accompanying drawing, and more particularly to Figure 1, 1 designates a shell, which as shown is of paper, has a metallic base 2, and a base wad 3. A battery cup 4 of any suitable construction forms a primer cavity in which is arranged an anvil 5 cooperating with the priming composition, while the partly empty primer cavity has a flash hole as shown. The propellant charge is shown at 6 and is confined by wadding 7, over which is the shot charge 8 confined by the shot wad 9 and the crimped end 10 of the shell.

The propellant charge preferably consists of dense colloided nitro-cellulose powder; this powder is however progressive, and in accordance with one embodiment of this invention the powder grain is surface treated so that the surface layer of the grain is modified in order to cause the outer layers to burn more slowly under the same conditions than the dense colloided nitro-cellulose core. The powder is, however, so modified that it will burn completely, but progressively, under the conditions present in a shot gun when the shot shell containing that propeller is fired; accordingly the powder is so subdivided and surface treated as to meet these conditions.

The propellant charge is confined in the shell by the wadding. This wadding is, however, heavy or thick so as to not only confine the charge initially, but so as to also seal the bore sufficiently that the required pressure is sustained for a sufficient extent along the barrel in order to effect complete combustion of the charge. The primer is moreover a hot primer so as to generate a sufficient volume of flame in order to fully ignite the powder. The powder itself is also of sufficient fineness as to be not only properly ignited by the primer but so that the required pressure and temperature will be maintained to maintain the combustion.

Now the heavy wadding would ordinarily required a longer shell; however, in view of the fact, as will hereinafter appear, that a long base wad is not required, the standard bulk powder base can be used; this in connection with the smaller volume of the powder charge, permits the employment of the required heavy wadding in a standard shell with a shallow or short bulk powder base.

A practical example of an embodiment of this invention will now be described; it is understood, however, that this invention is not limited to this particular example, but that various modifications may be made without departing from the essential features of this invention.

The drawing shows the proportions of a twelve gauge shell, containing, for example, a four-tenths (0.4) grain primer of fulminate of mercury, potassium chlorate and antimony sulphide. The wadding may be of felt or any other suitable material, while the base wad corresponds in this particular embodiment to that of a standard bulk powder base.

The powder charge consists of dense colloided nitro-cellulose, which can be made in any usual or suitable manner well known to those skilled in the art. This powder is then granulated or subdivided, by cutting or grinding in any suitable manner, so that it will pass a thirty mesh screen. This powder is then surface treated in any suitable manner so as to render it progressive burning. As a practical example the treating agent is a deterrent such as dinitro-toluene, which can be applied in the usual manner, as by rumbling in a rotating drum, at a temperature of about 80° C. for about one-half hour using about two percent of the agent relative to the weight of the powder; so that the powder grains will each become impregnated with the treating agent. The object is to subdivide the powder to an extent sufficient, and to impregnate each powder grain to an extent sufficient, as to cause the powder when confined and primed in a loaded shot shell as previously described, to burn progressively when fired in a shot gun. For a twelve gauge

shell, the powder charge is from 35 to 40 grains and this will have a volumetric density of two and one-half drams on a bulk basis, as compared to three and one-half drams of bulk powder. Accordingly the volume in the shell is sufficiently small as to permit the use of a heavy wadding as previously described.

The action of a shell embodying this invention is striking and is strikingly illustrated in Figure 2, as compared to shells using other smokeless powders. Thus I is the pressure curve of a twelve gauge shell containing Walsrode powder, i, e., a pure uncoated dense colloided nitro-cellulose powder; II is the pressure curve of a corresponding shell containing (Infallible) a nitro-cellulose-nitro-glycerine powder; III is the pressure curve of a corresponding shell containing bulk smokeless powder; while IV is the pressure curve of a corresponding shell embodying this invention. In this figure the points were developed by pressure readings at successive points along the barrel of a shot gun, measuring from the breech. Figure 3 further shows a comparison of the barrel times of the corresponding shells whose pressure curves are shown in Figures 2, the "standard" being a definite standard and staple smokeless powder used for checking purposes; the barrel time was measured by determining the time interval in seconds between the fall of the hammer until the charge of shot emerged from the muzzle of the gun. The gun used was a twelve gauge gun having a full choked barrel of a length of twenty-nine and one-half inches.

It will be seen that in the loaded shot shell embodying this invention, the progressive burning smokeless powder develops and sustains a pressure which propels the shot charge gradually out of the shell and for an extended distance along the gun barrel, with a material increase in barrel time as compared to shells using standard smokeless powder.

Upon reference to Figure 2, it will be seen that while shells I, II and III develop a high initial pressure dropping rapidly, shell IV develops not only a very much lower initial pressure, but this initial pressure is maintained nearly uniform while the shot charge moves out of the shell (whose length for twelve gauge is from two and one-half to two and three-fourths inches) and even after the shot charge has moved out of the shell. In fact the pressure developed by the progressive burning powder is maintained nearly uniform for a considerable distance along the gun barrel and even thereafter is maintained above the corresponding pressures of the other shells. Accordingly the progressive burning powder is adapted to develop and sustain a pressure which starts the shot charge gradually out of the shell and propels the same gradually through an extended distance along the gun barrel. It will also be noted that the area bounded by curve IV is substantially equal to those bounded by any of the other curves I, II or III. To still more strikingly illustrate the comparison, curve V has been developed from curve IV by making the initial pressure of IV equal to the initial pressure of I. The area bounded by curve V is, of course, much greater than that bounded by any of the other curves I, II or III.

The striking different characteristics of the shot shells embodying this invention and those of the prior art are believed to be due to the following: A powder charge in a shot shell starts to burn from the outer surfaces of the individual grains while sufficient pressure is being built up to overcome the inertia of the shot charge and start it; the combustion then continues to the centers of the grains as the shot charge moves along the barrel. It is, therefore, clear that in the shells of the prior art (I, II, III,) the maximum pressure must be developed before the shot charge has moved any appreciable distance or has even moved out of the shell; accordingly, the pressure will drop very rapidly as the shot charge moves along the barrel. Where, however, the powder charge in a shot shell embodying this invention is progressive burning, as by coating or impregnating the powder grains with a deterrent, then the initial combustion rate is retarded substantially and sufficiently to develop its maximum pressure an extended distance along the gun barrel so as to sustain a nearly uniform pressure while the shot charge moves out of the shell. This is due to the fact that the combustion of the grains and at the surfaces thereof will be retarded so that the shot charge is started on its course at a lower pressure, while the maximum pressure is developed and sustained for an extended distance along the gun barrel; this latter is due to the increased rate of combustion of the powder grains after the coating or impregnation has been consumed. That this action takes place is clear from curve IV. The factors of granulation, coating or impregnation, etc., must, however, have special reference to the conditions encountered in a shot gun as distinguished from the conditions encountered in a rifle as herein explained.

This diagram, therefore, shows that in the shell embodying this invention, not only is the same energy released and imparted to the shot, but at a much lower maximum pressure than with the shells of the prior art; accordingly the breech pressure is not only considerably lower under the same conditions, but for the same breech pressure the energy released and imparted to the shot will be very much greater. Moreover since the maximum pressure is maintained nearly uniform for a considerable distance along the barrel and main-

tained thereafter at a higher value, the shot charge will be more gradually and therefore more uniformly accelerated. This latter point is additionally borne out by the material increase of the barrel time as noted in Figure 3. In accordance with this invention, not only is the muzzle velocity and therefore the range materially increased, but the stringing of the shot is materially reduced, while the pattern is materially improved; this is due to the more gradual rise of pressure and the more uniform acceleration imparted to the shot charge. The comparatively gradual rise of pressure causes the wadding and the mass of shot in front thereof to be started gradually; accordingly the movements imparted to the various shot of the charge are more nearly equal so that the shot travel at more nearly equal and uniform velocities towards the target. The reduction of the stringing of the shot results in the attainment of greater accuracy in hitting a target, especially when moving across the line of flight of the shot. Actual tests show that the effective range is increased by more than twenty yards, for long range shooting, while the pattern is materially improved and the stringing of the shot is reduced by one half, as compared to other shells. Furthermore in the shell embodying this invention, a given charge of shot (such as 1¼ oz., Figure 3) can be propelled a greater distance with a given propellant powder charge as compared to other shells; accordingly a greater shot charge can be projected the same distance. The desired results, namely, the higher velocity, closer pattern, less shot stringing and longer reaching results are however accomplished without increase but rather with decrease of breech pressure, due to the fact that the combustion continues along an extended part of the gun barrel, rather than within a short distance and within the breech.

These results are accomplished by the employment of the combination of elements embodied in the shell as described. The powder being of granular form, is subdivided to an extent sufficient so as to not only be initially ignited, but so that the required pressure and temperature will be maintained to maintain the combustion. The surface treatment of the dense colloided nitro-cellulose powder not only retards the initial combustion and therefore permits the pressure to build up gradually, but this modification of the surface permits the subdivision to be carried to the desired fineness so that the grains will be properly ignited by the primer under the conditions encountered in a shot shell, when the powder charge is confined by the wadding. This surface treatment moreover renders the ignition more regular and uniform, even if the grains vary somewhat in size, due to the fact that the retarding effect tends to make the ignition of different sized grains more nearly the same than where the dense colloided nitro-cellulose is left untreated. Accordingly different shells of the same gauge will readily give the same results, which is so desirable and even necessary.

Upon ignition of the charge by the hot primer, the powder grains will become ignited, especially since they are confined by the heavy wadding. Such confinement will, however, cause the pressure to build up, although the initial pressure is much less than where untreated powders are used. Accordingly the pressure will be sustained as is necessary for the continued combustion of the dense colloided nitro-cellulose. As now the burning proceeds through the impregnated surface to the dense colloided nitro-cellulose core, the rate of combustion will increase so that the desired pressure is maintained, especially since the heavy wadding provides sufficient resistance to the expansion of the gases to maintain the pressure. The result is, therefore, that the combustion is uniformly accelerated, even after the confining wadding and the shot begin to move so that the pressure is sustained nearly uniform for an extended distance along the gun barrel; the result is that the shot charge is uniformly accelerated under a lower initial pressure sustained for an extended distance along the gun barrel.

It will, therefore, be seen that the final result is due to a combination of factors found in the shell embodying this invention. The small bulk of the propellant charge permits the use of heavy wadding, thereby forming a good gas seal and accordingly more resistance to the expansion of the gases. The employment of a hot primer and the great resistance of the confining wadding enables a surface treated or progressive dense colloided nitro-cellulose powder to be used. The surface treatment enables the powder grains to be subdivided to an extent sufficient to permit such ignition under the conditions encountered in a shot shell, while this treatment further makes the ignition of the grains uniform and reliable. The ordinary non-progressive dense colloided nitro-cellulose powder as heretofore employed in shot shells, under similar conditions would produce dangerous breech pressures, while the progressive powder burns in such a manner that the pressure is distributed over a large area, thus reducing the pressure per unit of area and also reducing the amount of energy used in overcoming the inertia of the shot charge. This conserved energy acting on the moving charge and the uniform acceleration imparted thereto increases the velocity.

While the best results have been obtained by the combination of elements in a shot shell as heretofore described, in which a propellant charge is a dense colloided nitro-cellulose,

suitably subdivided and surface treated, it will be understood that such powder may be otherwise treated in order to burn progressively when fired in a shot gun. Furthermore improved results are obtained by the employment of other nitro-powders when rendered or treated or disposed so as to burn progressively when fired in a shot gun. Thus while the ordinary nitro-cellulose-nitro-glycerin powders do not burn progressively, as has been previously described, they can be made or treated so as to burn progressively. This can be accomplished by so incorporating with the nitro-cellulose and nitro-glycerin, preferably during the course of manufacture, a cooling or slowing agent having the action of reducing the temperature of burning and slowing up the combustion in such a manner as to produce the desired result. There are many compounds which may be used for this purpose, most of which are exothermic, among them being: vaseline and similar products, alkaline bi-carbonates, either alone or mixed with vaseline, diethyl diphenylurea, dimethyl diphenylurea, cyanamide, tartrates, olive oil, castor oil, fats and resins, soaps, oxalates, starch, dextrine, and diphenalamin. Such nitro-cellulose-nitroglycerin powders, containing from 35% to 40% of nitro-glycerin, together with a cooling or slowing agent, may be surface treated as heretofore described in order to still further enhance their progressive burning action in a shot gun.

It is further obvious that various changes may be made in details without departing from the spirit of this invention; it is, therefore, to be understood that this invention is not to be limited to the specific details shown and described.

Having thus described the invention, what is claimed is:

1. A shot shell containing a primer, a propellant charge of granular smokeless powder, a shot charge and wadding between the propellant and shot charges, the powder being subdivided to an extent sufficient and containing a deterrent but sufficiently primed and confined so as to burn progressively when fired in a shot gun.

2. A shot shell containing a primer, a propellant charge of granular dense smokeless powder, a shot charge and wadding between the propellant and shot charges, the powder being subdivided to an extent sufficient and treated with a deterrent but sufficiently primed and confined so as to burn progressively when fired in a shot gun.

3. A shot shell containing a propellant charge of granular dense colloided nitro-cellulose powder, a shot charge and heavy wadding between the propellant and shot charges, the powder being subdivided to an extent sufficient and treated with a deterrent but sufficiently primed and confined so as to burn progressively when fired in a shot gun.

4. A shot shell having a bulk powder base and containing a comparatively small bulk propellant charge of granular dense colloided nitro-cellulose powder, a hot primer, a shot charge and heavy wadding between the propellant and shot charges, the powder being subdivided to an extent sufficient and treated with a deterrant but sufficiently primed and confined so as to burn progressively when fired in a shot gun.

5. A shot shell containing a propellant charge of granular progressive burning smokeless powder, a shot charge and wadding between the propellant and shot charges, the powder being sufficiently primed and confined and having its initial combustion rate retarded sufficiently to sustain a nearly uniform pressure through an extended distance along the gun barrel after the shot charge has moved out of the shell.

6. A loaded shot shell containing a primer, a shot charge, wadding and a shot propelling charge of granular progressive burning smokeless powder whose initial combustion rate is retarded substantially, and which is sufficiently primed and confined so as to burn progressively when fired in a shot gun.

7. A loaded shot shell containing a primer, a shot charge, wadding and a shot propelling charge of granular progressive burning smokeless powder whose initial combustion rate is retarded sufficiently and which is sufficiently primed and confined to develop its maximum pressure and sustain the same an extended distance along the gun barrel.

In testimony whereof I affix my signature this 23rd day of August, 1923.

JOHN M. OLIN.